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# The landscape, vegetation and botany of the Semporna Islands of Sabah, Borneo: A conservation perspective

**K.M. Wong[1], R. Nilus[2], G.H. Petol[2], J.B. Sugau[2], J.T. Pereira[2] & R.C. Ong[2]**

[1] Institute of Biological Sciences,
University of Malaya,
50603 Kuala Lumpur, Malaysia

[2] Forest Research Centre,
Sabah Forestry Department,
P.O. Box 1407, 90715 Sandakan,
Sabah, Malaysia

**Summary.** The Semporna Islands, including the volcanic Bodgaya cluster of islands and others within a proposed Park area, have many interesting and unique aspects in their landscape, vegetation and botany worthy of special protection. Bodgaya, Boheydulong and Tetagan are Sabah's only islands in the Sulu volcanic chain and the first two have spectacularly precipitous topography. Their vegetation includes beach vegetation, mangrove, coastal mixed forest on steep slopes of weathered volcanic material, rockface vegetation and scrub vegetation developing atop rock outcrops that is both floristically and physiognomically unique in Borneo. Key species in the scrub vegetation include *Dracaena multiflora*, *Cycas rumphii* and *Euphorbia lacei*. The dracaena and a host of other species found on these islands represent either local or regional endemics, as well as very rare species in Borneo.

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The proposed Semporna Islands Park, roughly northeast of Semporna town in east Sabah at the southern fringe of the Darvel Bay and some 23 km off the coast, covers an area of some 325 sq. km. including the islands of Sibuan, Maiga, Mantabuan, Tetagan, Bodgaya and Boheydulong (Fig. 1). [Note: Variation in name and spelling exists for Bodgaya, also called Gaya, and Boheydulong, also called Boheydulang or Bohaydulong, but the form of the names used in this report will be kept consistent with other literature associated with the Semporna Islands project.] The area lies approximately between 4° 32'N and 4° 42'N, and

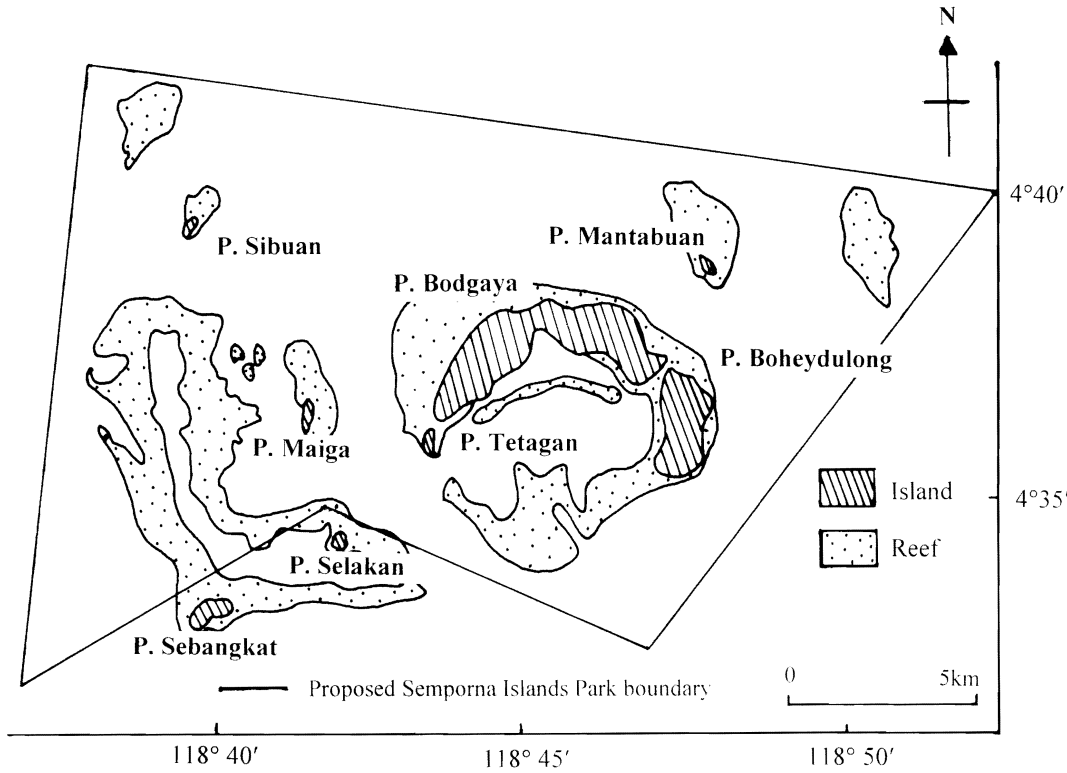


**Fig. 1.** The proposed Semporna Islands Park. (Drawn by J.T. Pereira)

118° 36'E and 118° 53'E. Sibuan, Maiga and Mantabuan are very small raised coral beds that form relatively flat, white-sand islands where the vegetation is principally coconut. Sibuan, however, has a notable narrow strip of beach forest formed mainly by *Pisonia grandis* (Nyctaginaceae) trees (reaching 12–18 m tall) together with smaller *Premna foetida* (Verbenaceae) and a narrow-leafed species of *Dracaena* (Dracaenaceae). An individual of the strangling fig, *Ficus microcarpa* (Moraceae), was also seen there. This *Pisonia* forest is particularly well developed on Sibuan and is absent from the other islands in the proposed Park area and should be preserved.

This report is based on a survey carried out in October 1998. It will concentrate on the main islands of Tetagan, Bodgaya and Boheydulong, which are the largest islands and form the main interest in conservation terms. These three are sometimes also referred to as the Bodgaya Islands.

While Tetagan has never been designated for any particular land use, Bodgaya Island was gazetted as the Bodgaya Forest Reserve in September 1933 (Section 28 of the Land Ordinance 1930) but this declaration was later revoked in July 1977 (Section 22(1) of the Forest Enactment 1968) as a preliminary to establishing a national park. Boheydulong was

a Bird Sanctuary for over 40 years, from 1933 until 1978. Their legal land status is that of stateland (i.e., without special Forest Reserve or Park status) at present, until the State Government's intention to gazette the Semporna Islands Park is fully formalized. An outstanding issue is the numerous claims for land compensation from the State. Recent attention re-focussed on the islands after surveys associated with the WWF "The Seas Must Live" Campaign of 1977–78 highlighted the pristine conditions and rich coral-reef life found in the lagoon and surrounding areas (Wood & Tan 1987, George & George 1987, Clark 1987, Wood & Wood 1987, Wood *et al.* 1987). The vegetation and plant life of these islands have not been given any special attention in the published literature and there has only been a preliminary account in the expedition report of the 1980 survey (Wood 1981).

## GEOLOGY AND TOPOGRAPHY OF THE BODGAYA ISLANDS

In Sabah, the only occurrence of volcanic and associated intrusive rocks is in the Semporna peninsula (Kirk 1962, 1963). These are mainly of late Tertiary (Pliocene) and Quaternary origin and appear related to other volcanics in the so-called Sulu tectonic arc from Semporna, through Tawitawi island, Jolo island, Basilan island, to Zamboanga in Mindanao. The Semporna volcanic sites include the Mt Magdalena–Mt Wullersdorf area behind Tawau (Lim 1981), the Mt Pock area east of this (Lee 1988) and the Bodgaya cluster of islands off Semporna (still on the Sunda continental shelf).

Tetagan, Bodgaya and Boheydulong, in that order from west to east, form an inverted-U pattern around a lagoon that is a former volcanic crater about 6.5 km across. This lagoon has been referred to as Gaya Bay (e.g., Kirk 1962). These islands represent the highest remaining portions of the ancient volcanic crater rim (the entire southern part of the rim is now submerged and its position is indicated only by a curved reef formation) (Fig. 2). They are formed from Quaternary pyroclastic material (i.e. material of fragmental texture ejected during explosive volcanic activity) best described generally as tuff (when it is fine-grained), volcanic breccia (when larger angular fragments mostly up to 0.5 m across are embedded within the fine material), or agglomerate (when the included large fragments are more rounded). The rocks forming the high cliffs and large shore outcrops are mainly pale to dark grey in colour (containing an intermediate amount of dark minerals) and so have been described as andesite breccia (Kirk 1962). In the proposed Semporna Islands Park, these islands alone bear forest of the usual sense, i.e., forest formed of a mixture of species from the main lowland rain forest tree families and in extent more than just a fringe of trees along the beach.

Bodgaya island, the central island, is the largest (about 795 ha and 8 km long), with its main peak also called Bodgaya and reaching 455 m in elevation. East of Bodgaya peak is another notable peak, reaching 427 m; both these are on the western 'arm' of the island. Yet another notable peak (366 m) is found, on the eastern arm of Bodgaya island. Between the two arms of the island is a 'neck' portion that is a low recess separating the main rock outcrop of each

**Fig. 2.** Bodgaya Island, across the 'Gaya Bay' from Boheydulong Island. (Photo: K.M. Wong)

arm. These outcrops are essentially the rocky spine of the island, and the sides of the outcrop form principally steep-sided to vertical cliffs. These features form an impressive relief that probably gave the island its popular local name, Bodgaya, which means "impressive mountains" in the Bajau language. All around these main rock outcrops are steep slopes averaging 45–60° in incline beginning from elevations of 10–100 m until sea level. These slopes, on which forests with the biggest trees occur, are formed of a dark-coloured, weathered volcanic material. Small, mostly seasonally sustained freshwater streams are found here and there on Bodgaya island.

The easternmost island, Boheydulong, is less than half the size of Bodgaya island (312 ha). The highest point on its main rock outcrop is Boheydulong peak (353 m) to the south. As on Bodgaya, there are steep to vertical cliffs and steep slopes of weathered tuff material all around the outcrop. The names *bohey* (= water in Bajau) and *dulang* or *dulong* (= pools or depressions) refer to a number of oval rock pools, of roughly 2–3 m across, weathered in the volcanic rocks along the main freshwater stream course emptying into the sea on the eastern side of the island. The physical state of these rock pools, however, pales in comparison to their role in the local legend where a princess in confinement resorts to them for a source of fresh water.

Tetagan, the smallest of the three islands and at the western end of Bodgaya, has no relief of note, rising to only about 80 m. It contains only regenerating forest, as in parts of the

other two islands, and mention of this vegetation will be made later. As the terrain of Tetagan does not present huge logistic problems for wood-cutting and settlement activities (the same is true in some less steep and similarly affected parts of Bodgaya and Boheydulong islands), clearance of its original forests is not surprising. This may have, in fact, inspired its name (*tetagan* means "hospitable site" in Bajau). It is said to have had a flourishing village in 1887 (Piper 1984).

## THE VEGETATION

There has been no detailed survey of the vegetation of these islands. Limited botanical collecting was carried out by (first, North Borneo, later Sabah) Forestry Department collectors as early as 1934 (Orolfo), as well as in 1965 (Jaswir Singh, Nordin, Ahmad Talip, Awang Abdullah), 1980 (C. Phillipps, Aban, Jumatin, Tuyok) and 1997 (Lim, with Kiew and Anthonysamy). With the exception of the 1980 WWF survey, these collections were probably made as day-long trips out from Semporna.

In addition to the low, scrub-like vegetation on the main rock outcrops and the taller forests on porous, weathered volcanic soils forming the steep slopes around them, there are scattered patches of beach vegetation behind small areas of white-sandy beach as well as poorly developed mangrove vegetation where some sand and mud are deposited, respectively. On the steep rock faces the ledges and cracks accumulate some soil and allow some plants to thrive.

Figs. 3 & 4 show the general distribution of four of five main vegetation communities according to site conditions, which can be briefly stated as follows: (1) coastal mixed forest,

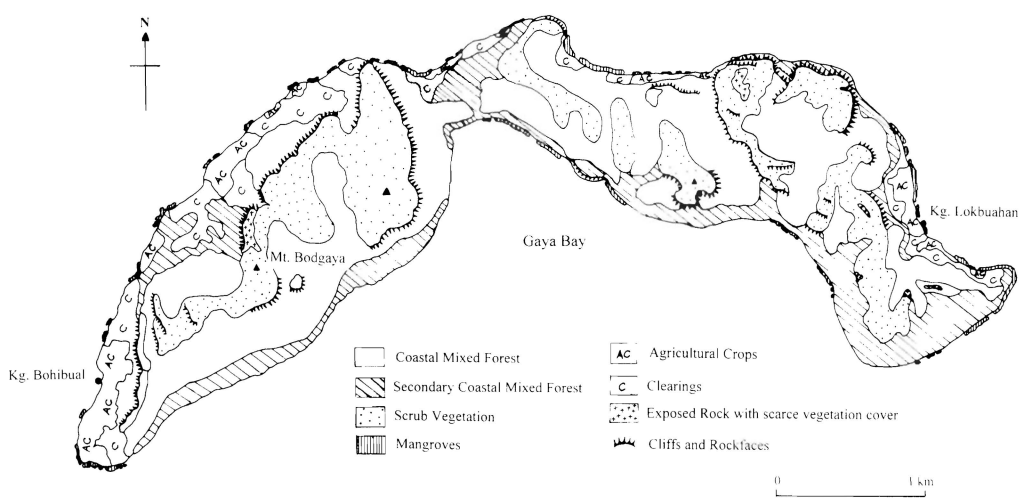


**Fig. 3.** Vegetation map of Bodgaya Island, based on aerial photograph interpretation, 1995. (Drawn by R. Nilus, H. Petol, R.C. Ong & J.T. Pereira)

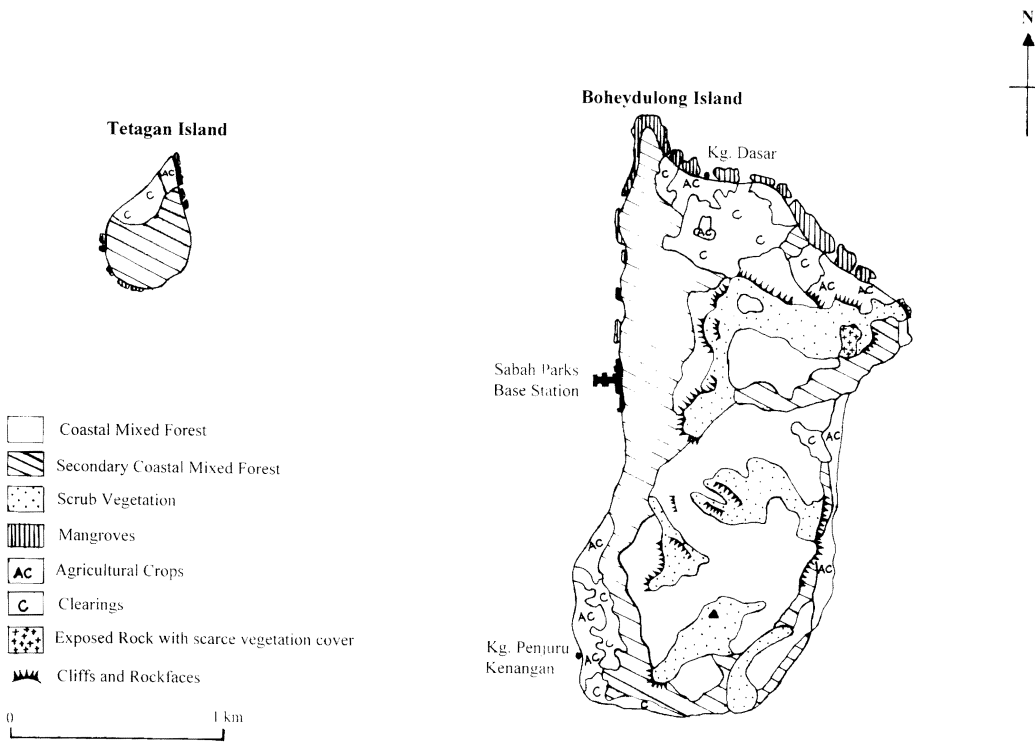


**Fig. 4.** Vegetation map of Tetagan and Boheydulong islands, based on aerial photograph interpretation, 1995. (Drawn by R. Nilus, H. Petol, R.C. Ong & J.T. Pereira)

(2) scrub community, (3) rockface vegetation, (4) mangrove vegetation. The fifth type, beach vegetation, occurs on tiny sand beaches scattered around the islands and is not discernible by aerial photo-interpretation, consequently it is left out of the vegetation community map. A typical West-East profile of Boheydulong Island is provided in Fig. 5, showing the distribution of the various vegetation types according to site conditions, in particular the extent of soil development.

**Coastal mixed forest.** This is the richest plant community found on the islands, represented by at least 124 species of tree found in 86 plant families. Physiognomically, this forest resembles mixed dipterocarp forest although floristically there were only three species of dipterocarp (Dipterocarpaceae) found during the survey (*Shorea guiso*, *Hopea beccariana* and *H. sangal*). Of these, *S. guiso* was the most common, with a scattered distribution on the steep weathered tuff slopes and some localized patches of regeneration. *Hopea beccariana* was most frequently encountered as gregarious populations, especially in the moister valleys on Bodgaya island. *Hopea sangal* also had a scattered distribution but was much more infrequent than *S. guiso*.

Although this forest in general terms falls within the definition of mixed dipterocarp forest (Whitmore 1984, Ashton 1995), we prefer to use the term "coastal mixed forest" here to

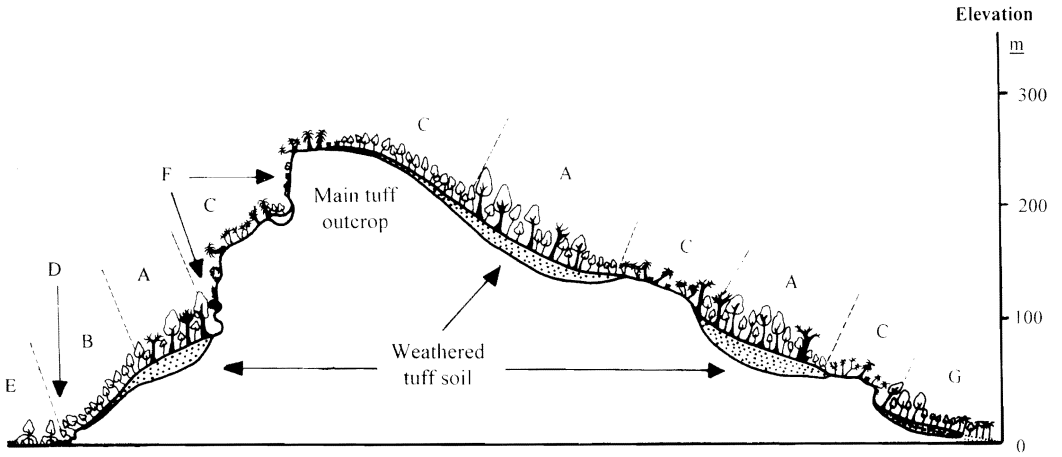


**Fig. 5.** A typical west-east profile of Boheydulong Island, illustrating the occurrence of the various vegetation types according to site conditions. (Drawn by R. Nilus, H. Petol, J.T. Pereira & K.M. Wong) A = coastal mixed forest; B = secondary coastal mixed forest; C = scrub vegetation; D = beach vegetation; E = mangroves; F = rockface vegetation; G = agricultural crops.

draw attention to the predominance of a number of species restricted to or more commonly found as big trees in coastal sites, such as *Garuga floribunda* (Burseraceae), *Vitex pinnata* (Verbenaceae), *Mimusops elengi* (Sapotaceae), *Intsia bijuga* (Leguminosae) and *Canarium asperum* (Burseraceae). Other less common species here but which are also limited to a coastal distribution generally include *Sterculia foetida* (Sterculiaceae), which also occurs as smaller individuals in the scrub vegetation (see later). Further distinctions exist between this coastal mixed forest and the more typical lowland mixed dipterocarp forest in Borneo, such as a commonness of spiny plants (including *Capparis spinosa*, Capparidaceae; *Severinia disticha*, Rutaceae; *Caesalpinia bonduc*, *C. crista* and *C. latisiliqua*, Leguminosae; and *Fagerlindia emanuelssoniana*, Rubiaceae).

Structurally, this coastal mixed forest reaches 20–30 m tall (Fig. 6). Although it is generally difficult to recognize distinct strata as in the case of well-developed mixed dipterocarp forest elsewhere on flatter ground, emergents protruding from the general canopy grow to 35–40 m tall; these are mainly *Garuga floribunda*, *Canarium asperum*, *Koordersiodendron pinnatum* (Meliaceae) and *Vitex pinnata*, although *Shorea guiso*, *Hopea sangal*, *H. beccariana*, *Intsia bijuga*, *Homalium foetidum* (Flacourtiaceae), *Mimusops elengi*, *Drypetes kikir*, *D. littoralis* (Euphorbiaceae) and *Dialium indum* (Leguminosae) are also occasional emergents. The forest was noticeably taller in the moister valley sites, with the tallest trees reaching 30–40 m.

There is also a high density of wild individuals of the *langsat* fruit tree, *Lansium domesticum* (Meliaceae), in the forest understorey in many places on Bodgaya island, and an equally impressive density of the trees, *Drypetes longifolia* (Euphorbiaceae) and *Cynometra inaequifolia* (Leguminosae) in the forest understorey at some sites on the same island.

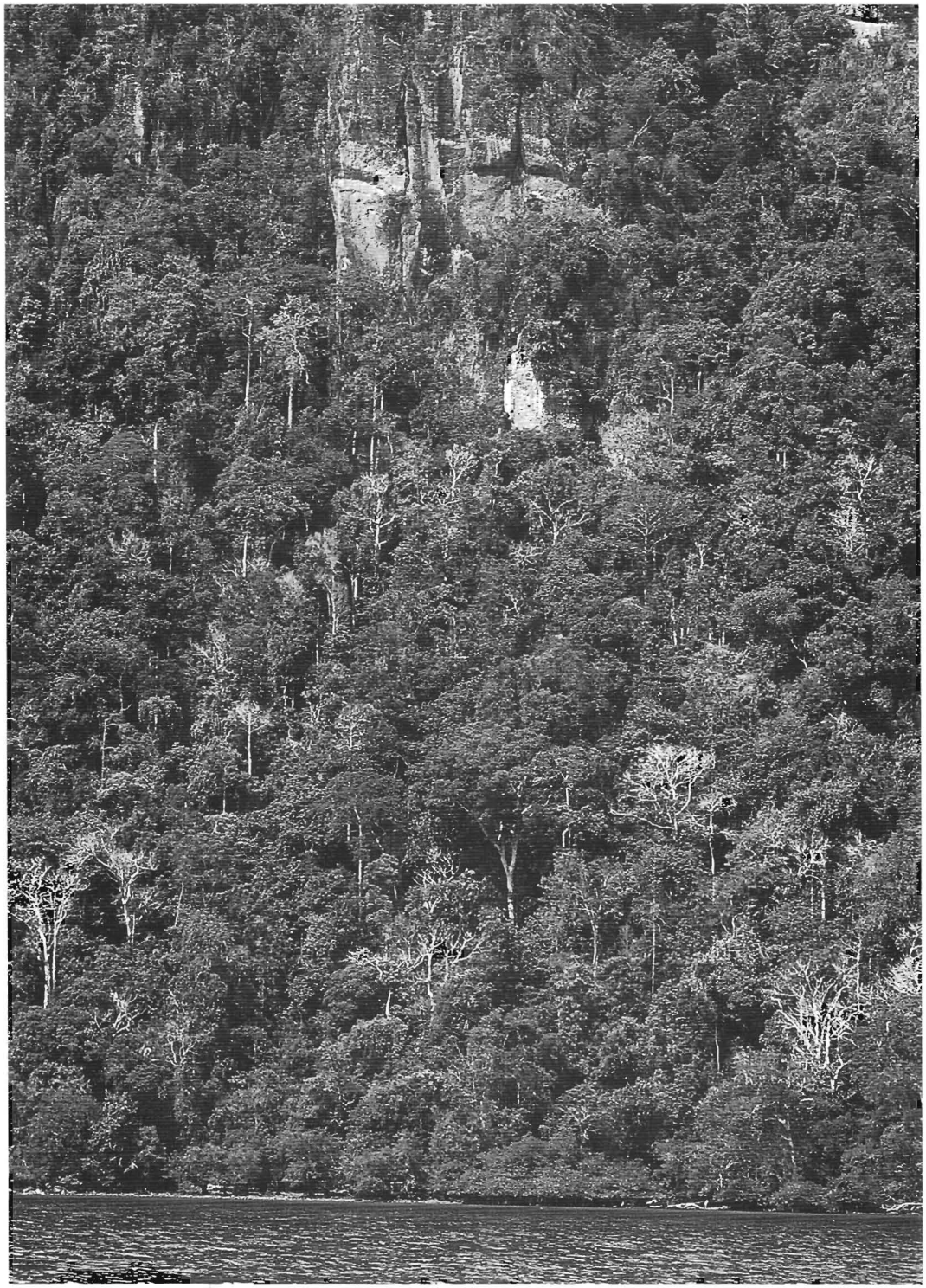

**Fig. 6.** Coastal mixed forest on Bodgaya Island, developing on steep slopes, backed by rockface vegetation, with a patch of *Rhizophora* mangrove on the sea edge (near centre). (Photo: K.M. Wong)

Woody climbers were common only in scattered sites, including *Caesalpinia bonduc*, *C. crista*, *C. latisiliqua* and *Dalbergia cochinchinensis* (Leguminosae), *Desmos chinensis* and *Friesodielsia argentea* (Annonaceae), *Tetrastigma dubium* and *T. papillosum* (Vitaceae), and *Myxopyrum coriaceum* (Oleaceae). Of note was a species of wild peppervine, *Piper* sp. (Piperaceae: WKM 2844) which developed woody stems to 4 cm diameter: this species was common throughout the three main Semporna islands but the largest sizes were seen on the southwest slopes of Boheydulong island. Epiphytes were mainly either ferns (chiefly *Asplenium nidus*, Aspleniaceae), *Poikilospermum cordifolium* (Cercropiaceae) or figs (such as *Ficus deltoidea*) (Moraceae) and were not particularly abundant. The ground flora was sparse but here and there were localized patches of the ferns *Tectaria* (WKM 2847) (Dryopteridaceae) and *Adiantum malesianum* (Lindsaeaceae), among others, but perhaps the most common (but still gregarious) herb on the weathered tuff slopes was a rosette-forming Acanthaceae with pale lime-yellow flowers (WKM 2838). The identity of the last needs to be further researched and may represent a species of special interest. Herbaceous groups that prefer moist substrates, common elsewhere, such as the gingers, were noticeably absent, although on Bodgaya island *Tacca integrifolia* (Taccaceae)and *Calanthe triplicata* (Orchidaceae) were found near the sheltered base of some cliffs. Also of sporadic occurrence, on boulders in deep shade, were the ferns *Pteris ensiformis* (Pteridaceae) and *Asplenium polyodon* (Aspleniaceae).

No erect palms (Palmae) were encountered in the forest on the islands, with the exception of small populations of *Arenga undulatifolia*, endemic to Borneo but a relatively common species. However, three species of rattan were noted, viz., *Calamus usitatus* (principally a Philippine species but in Sabah known from the Lahad Datu, Semporna and Tawau areas), *C. subinermis* (a largely coastal species in Sabah that is perhaps conspecific with closely related forms in the Philippines), and *C. diepenhorstii* var. *major* (endemic to the Lahad Datu and Semporna areas in Sabah). The rattans were not abundant at all.

**Scrub vegetation.** A scrub-like community was recognized on the two main islands, forming principally on the top of the major rock outcrops, on near-horizontal or gently sloping surfaces (Fig. 7). This community is totally absent from Tetagan island, but is a very significant vegetation associated with the rock formations on the other two islands.

The most distinctive life forms aside from a few dominant tree species in this scrub community include the yucca-like *Dracaena multiflora* (Dracaenaceae) (Figs. 8 & 9) forming ascending branches and commonly growing to 10 m tall; the palm-like *Cycas rumphii* (Cycadaceae) with stems to 4 m tall and 10–30 cm diameter, and the cactus-like succulent *Euphorbia lacei* (Euphorbiaceae) (Fig. 10), growing to 6 m tall. *Dracaena multiflora* is a new record for the Bornean flora, previously documented only for the Philippines (including the Sulu archipelago) and Sulawesi. The cycad is distributed from Java and Borneo eastward to Sulawesi, Maluku and Papua New Guinea and is the main species in a host of taxa previously confused with it, all of which are characterized by a coastal distribution and rather large, buoyant seeds (Hill 1994), although the taxon on the

**Fig. 7.** Scrub vegetation on Bodgaya Island, from the southwest. (Photo: K.M. Wong)

**Fig. 8.** Yucca-like *Dracaena multiflora*, significant in the scrub vegetation community, on the south side of Bodgaya Island. (Photo: K.M. Wong)

**Fig. 9.** A taller individual of *Dracaena multiflora* on Boheydulong Island. (Photo: K.M. Wong)

**Fig. 10.** The cactus-like *Euphorbia lacei* in the scrub community, Boheydulong Island. (Photo: K.M. Wong)

Semporna islands (Fig. 11) would be called *C. edentata* following a recent paper by Laubenfels & Adema (1998). The identification of *E. lacei* rests upon comparison with Burmese and Thai material (Airy Shaw 1975) and the same taxon was also noted as being a conspicuous component of the vegetation on the Segarong limestone on the nearby Semporna peninsula (Ong & Lim 1998). This *Euphorbia* also occurs on volcanic substrate on the nearby Timbun Mata Island (Airy Shaw 1975, Kiew 1998).

These taxa were sometimes dominant in patches over the rock surfaces but sometimes occurred in mixture with trees, often *Syzygium* sp. (JBS 363) (Myrtaceae), *Psydrax* sp. (WKM 2866) (Rubiaceae), *Decaspermum fruticosum* (Myrtaceae) and *Croton krabas* (Euphorbiaceae). In places, particularly the flatter tops of some parts of the outcrops, *C. krabas* can be a dominant low tree cover, and likewise the scrambling *Schefflera elliptica* (Araliaceae) can be a very common plant.

As a whole, this scrub community is special: the combination of these three key life forms represented by *Dracaena multiflora, Cycas rumphii* and *Euphorbia lacei* does not occur anywhere else in Sabah or Borneo as far as is known, although it is to be fully expected that the same, or a very similar, scrub vegetation should thrive on the Philippine islands of the Sulu arc. This scrub community seems, therefore, unique in Borneo. Both the *Dracaena* and the *Cycas* can also be found growing at the sea fringe, on volcanicboulders and cliffs.

**The rockface vegetation.** The vegetation on rockfaces includes small patches of scrub, as described above, established on narrow ledges and in broad cracks, as well as a distinctive community that includes the true lithophytes (rock plants) such as the newly described *Paraboea leopoldii* (Gesneriaceae) (Wong, Pereira *et al.* 1999), found as small populations clinging to cliff faces (Fig. 12). Another lithophyte of note is *Selaginella tamariscina* (Selaginellaceae), a small plant of only 4–5 cm high, growing on exposed to partially shaded gently sloping rockfaces on both Bodgaya and Boheydulong islands. It forms a false trunk and resembles miniature tree ferns.

A brown-tomentose small fern that also grew in completely open conditions, forming thick tussocks in cracks and depressions on the rock face, is *Cheilanthes nudiuscula* (Adiantaceae). Another interesting species documented from the rock boulders was a *Hoya* sp. (JBS 395) (Asclepiadaceae), which was scandent from rock crevices and ledges and had conspicuous clusters of yellow flowers. Also restricted to rock faces, in open to semi-exposed conditions, was the erect herb, *Plectranthus* sp. (JTP 623) (Lamiaceae) and a creeping herb, *Belosynapsis ciliata* (Commelinaceae).

**Beach vegetation.** The small sandy beach areas, with the exception of those sites already disturbed by settlement activities (including the present survey base station at the former Kaya Pearl Company's installation on the western part of Boheydulong island), had good representations of the beach flora of Borneo. The typical sandy shore elements include the *mempari, Pongamia pinnata* (Leguminosae), the shore *dungun, Heritiera littoralis*

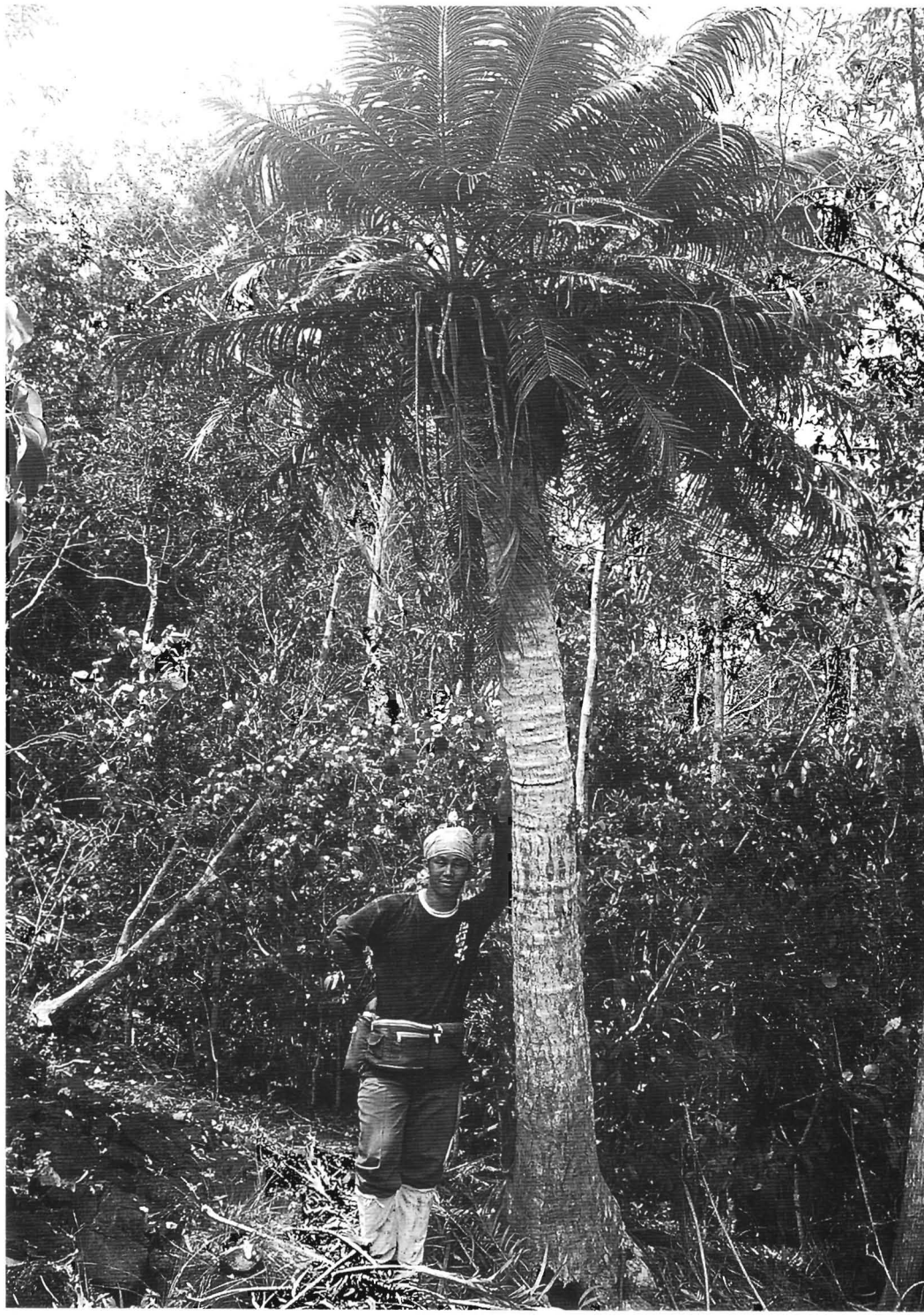

**Fig. 11.** *Cycas rumphii*, another significant element of the scrub community, Boheydulong Island. (Photo: K.M. Wong)

**Fig. 12.** Small populations of *Paraboea leopoldii* (characteristically pale-coloured), clinging to the rockface at the edge of the scrub-covered, gently sloping sides of the volcanic outcrop, Bodgaya Island. (Photo: K.M. Wong)

(Sterculiaceae), *Hibiscus tiliaceus* (Malvaceae), *Ximenia americana* (Olacaceae), *Alophyllus cobbe* (Sapindaceae), *Sesuvium portulacastrum* (Aizoaceae) and *Wedelia biflora* (Compositae). *Calophyllum inophyllum* (Guttiferae), *Thespesia populnea* (Malvaceae), *Scaevola taccada* (Goodeniaceae), *Pandanus odoratissimus*, *P. dubius* (Pandanaceae) and *Ipomoea pes-caprae* (Convolvulaceae), typical shore elements on the Bornean east coast sandy beaches, were found but were exceedingly rare. Other such beach elements, including *Casuarina equisetifolia* (Casuarinaceae), *Argusia argentata* (Boraginaceae) and *Barringtonia asiatica* (Lecythidaceae) were not encountered, possibly because they typify vegetation developing on deeper sand deposits. The limited sandy beaches of these Semporna Park islands can therefore be said to mainly harbour a *mempari–dungun* association. Immediately behind the beach, other trees such as *Clausena excavata* (Rutaceae) and *Buchanania arborescens* (Anacardiaceae) are quite common.

**Mangrove vegetation.** Like sandy beach vegetation, mangrove vegetation cannot be said to be well-developed around the islands of Tetagan, Bodgaya and Boheydulong. They occur mainly in spots around the island sheltered from strong currents and in enclaves where some deposition of silt and mud is possible.

Thus, although *Rhizophora mucronata* (Rhizophoraceae), *Avicennia alba* (Avicenniaceae), *Lumnitzera littoralis* (Combretaceae) and *Sonneratia alba* (Lythraceae) do occur and each can form nearly pure patches, these are restricted in area and often comprise smallish individuals. The northern and southern shores of Bodgaya island bear some fine patches of taller *Sonneratia* and *Lumnitzera*. The eastern shore of Tetagan has a tall stand of *Lumnitzera* worthy of note. Well-developed mangrove is therefore to be considered absent from these islands but the scattered mangrove patches around them will likely have some importance to the fisheries in the reef and lagoon areas.

## CONSERVATION PERSPECTIVES

Several major aspects may be specially discussed. These include special vegetation communities and noteworthy species, as well as the usefulness (both present and potential) of and disturbances to the plant life.

**Unique vegetation communities.** The most exciting terrestrial plant community on the Semporna islands is the scrub community developed on the volcanic rocks, particularly on the broad, gently sloping summits and ridges of the rock outcrops. In particular, the association among *Dracaena multiflora*, *Cycas rumphii* and *Euphorbia lacei* produces such a unique physiognomy that surely this kind of scrub forest must rank as one of Borneo's most unusual natural communities.

In addition to this, it may also be emphasized that the coastal mixed forest is very well developed on the steep slopes of weathered volcanic soil on the islands. It is doubtful if there are any such well developed coastal mixed forests on other islands off the Sabah east coast, as many such islands have already become very disturbed or do not have the significant combination of geology and relief such as found on Bodgaya and Boheydulong.

As such, it would not be presumptive to say that the Semporna islands hold some of the most special and unusual vegetation communities found in Sabah.

**Rare and endemic species.** The discovery of *Paraboea leopoldii* and a host of rare and interesting plant species suggests that whereas these islands are small, they are special. Because *Paraboea* spp. are mostly highly restricted in their distribution, and the Semporna islands species might only be found at one other locality on the main island of Borneo (Wong, Pereira *et al.*1999), it is to be regarded as an extremely rare plant species which will only find assured survival on the cliff faces of these Semporna islands with sufficient protection.

There were seven plant species documented for the Bornean flora for the first time from these islands (Wong, Sugau *et al.* 1999): *Antirhea edanoi* (Rubiaceae), *Cheilanthes nudiuscula* (Adiantaceae), *Dracaena multiflora*, *Fagerlindia emanuelssoniana*, *Rhyssopteris timoriensis* (also a new genus record, Malpighiaceae), *Selaginella*

*tamariscina*, and *Stemona tuberosa* var. *tuberosa* (new family record, Stemonaceae). These do not appear to occur elsewhere in Borneo and the presence of so many of them on the Semporna islands is noteworthy. Like *Paraboea leopoldii*, some of these as well as others are very narrowly restricted in distribution: *A. edanoi* (restricted to Tawi-tawi and Semporna islands in the Sulu arc); *Calamus diepenhorstii* var. *major* (restricted to the Lahad Datu and Semporna area); *Calamus usitatus* (narrowly distributed in the Philippines and Sabah's east coast); *Dinochloa darvelana* (Gramineae: Bambusoideae) (known only from the Darvel Bay islands, and found on Bodgaya island); *F. emanuelssoniana* (Palawan and Semporna islands). Aside from these, we may also consider the cactus-like *Euphorbia lacei* which in Borneo is only found, or only becomes conspicuous, on certain specialized substrates (limestone, volcanics) in east Sabah.

**Useful plants.** The utilization of trees as a timber resource was not significant, possibly due to the scarcity of commercial timber species. Illegal felling and encroachment appeared minimal: timber for local consumption included *Hopea sangal, H. beccariana, Shorea guiso, Intsia bijuga* and *Canarium asperum*. Some *Rhizophora mucronata* was collected for firewood and poles. Some recent tree felling was noted on both the southern and northern sides of Bodgaya island.

Apart from the species mentioned as having some use for timber, there are others noteworthy for their potential usefulness. These include the ranggu tree, *Koodersiodendron pinnatum*, which, although perhaps not advisably harvested here because of the steep slopes and overall low volumes, is of value to forestry as a seed source of special provenance. The *Mimusops elengi* trees on the island have unusually good form, with straight, tall trunks and could have some forestry potential. The presence of the large-cane rattan *Calamus subinermis* is not surprising as it is a coastal species, but preservation of wild seed stands is now of importance as progress is made in forestry to cultivate this species, possibly yielding cane of quality comparable to the commercially valuable *C. manan* (the manau cane of the furniture industry, which is a dwindling resource).

Plant species of ornamental value include *Thespesia populnea, Pongamia pinnata, Mimusops elengi, Pisonia grandis, Cycas rumphii, Dracaena multiflora*, the climber *Rhyssopteris timoriensis* and the palm *Arenga undulatifolia*. *Dracaena multiflora*, as yet unused in ornamental horticulture in Malaysia, has a great potential. *Cycas rumphii* is already a well-known ornamental plant but wild sources are increasingly scarce because of indiscriminate collection and destruction by ornamental-plant collectors. Thus, any protected wild source will always have value as a genetic bank for supporting the species in cultivation.

Wild fruit trees include *Severinia disticha*, whose value as a citrus rootstock is already established, and *Lansium domesticum* (the langsat), a much-cultivated local fruit tree. The wild populations here of langsat may not only generally represent important material for breeding but may also be somewhat more drought-resistant. No dead standing *langsat* trees

were seen during the survey in October 1998 on the porous weathered volcanic slopes, a remarkable fact considering that in many fruit plantations elsewhere in Sabah, *langsat* trees fell easy prey to the El Niño drought earlier in the year. This could well be because in the forest understorey, such smaller trees were better sheltered (compare the many dead trees in this forest which were mainly emergents with exposed crowns) than when they were planted in totally open orchard sites. Some degree of drought resistance, however, cannot be ruled out and it would be within natural populations such as found here that one might more easily find these genetic traits.

An equally interesting fact was that during October 1998, none of these forest *langsat* were fruiting on the islands, whereas everywhere in Sabah it was the height of the *langsat* fruit season. Off-peak flowering and fruiting is considered an important trait in fruit culture as it can be used to increase the period of fruit availability in a particular locality. Hence, again, the wild populations of a commonly cultivated useful species can be of much interest to agriculture.

The existence of plant species known widely for their medicinal properties is mentioned briefly only because no special study has been conducted to see how they, as well as other species, are being utilized by people living on or frequenting these islands. Thus, it would not be surprising that species such as *Justicia gendarussa* (Acanthaceae, widely occurring in the Indo-malayan region, used for treatment of fevers, flatulence, jaundice), *Premna foetida* (Verbenaceae, a common coastal plant in the Malay Peninsula, Java and Borneo, used for treating fever and asthma) and *Morinda citrifolia* (Rubiaceae, a common Indo-Pacific coastal species, used for treating fevers, skin ailments and respiratory problems) are already used in traditional medicine among people in the Semporna area, including on these islands.

**Disturbances to the vegetation.** A glimpse of human settlement on islands off the Semporna coast is provided by Piper (1984). The main settlements and cultivated sites that still exist on Tetagan, Bodgaya and Boheydulong are shown in Figs. 3 & 4. As the immigration of Bajau people from the Sulu islands into the Sabah east coast intensified between 1887 and 1892, sites accessible to settlement on Tetagan, Bodgaya and Boheydulong, especially near sources of fresh water, were occupied. Then Tetagan, for instance, was even a centre for earthenware production, the clay from the island said to be of good quality.

A study of 1948 aerial photographs of this area indicated that by then, vegetation over the whole of Tetagan and nearly all of the gentler slopes of Boheydulong (right up to the base of the rock outcrops) was already largely or completely secondary or cultivated. It was also possible to establish with these photographs that by 1948, only the northern coast of Bodgaya was inhabited, with significant disturbances at the northern part of the 'neck' portion of this island (secondary forest), the area surrounding Kampung (= village, abbreviated Kg) Lok Buahan on the eastern arm of the island (cultivated clearings), and the

easternmost tip of the island just adjacent to Boheydulong (secondary vegetation). This past forest clearance was for cultivation (food crops and fruit trees) as well as for timber, which was used for building boats and settlements, including the large and elaborate, somewhat durable offshore fishing traps known as *bungsud*.

There is no doubt that the more difficult terrain of Bodgaya, as well as its Forest Reserve status between 1933 and 1977, have resulted in less impact due to human activity on the original vegetation, and today it has several small villages in the less steep sites along its shores (associated with clearing for cultivation, sometimes significant in area) (Fig. 13). The main settlements on Bodgaya are Kg Boheybual (north coast of westernmost part), Kg Lok Buahan (north coast of easternmost part), and an unnamed settlement at the northern part of the island's 'neck portion'. In contrast, the entire vegetation of Tetagan island is either regenerating (i.e., secondary) forest or old fruit orchards, and on Boheydulong significant areas behind beaches and on the earth slopes have either been cultivated or now remain under regenerating forest. Although the inhabitants of Tetagan shifted elsewhere in the 1960s, past settlers still return to collect fruit from the orchards established there and sometimes stay several nights. Otherwise, the island is uninhabited. On Boheydulong (Fig. 14), the main settlements are Kg. Dasar (near the northern tip of the island) and Kg Penjuru Kenangan (southern tip), although the Kaya Pearl Company's jetty and structures in the midwestern part of the island still exist and portions are used by both a marine police team and Sabah Parks personnel. The Kaya Pearl Company established on Boheydulong in 1963, cage-culturing pearls in the lagoon over a concession of some 800 ha, but following a piracy attack, this installation was abandoned in 1993 (Fig. 15).

**Fig. 13.** A formerly cultivated site on the western extreme of Bodgaya Island, now grass-covered; banana cultivation proceeds to the right of this site. (Photo: K.M. Wong)

**Fig. 14.** Coastal mixed forest removed and replaced by cultivation, southeastern side of Boheydulong Island. (Photo: K.M. Wong)

Overall, it can be said that the significant areas cleared—notably on Tetagan and Boheydulong—have regenerated well over at least 50 years (1948–1998). The regenerating forest on the weathered volcanic slopes on these islands had a tree composition not significantly different from good, intact patches of the coastal mixed forest on Bodgaya island. The best regenerating forest patches were 20–25 m high. In the first place, these steep slopes of limited area were not the ideal sites for cultivation and the rocky, porous soils here are not suitable for many crops. The effect of past clearing on the steeper slopes is now difficult to assess, as any resulting landslips have had a long period to heal. Nevertheless, too many landslips and accelerated erosion from clearings will affect the quality of the coastal waters, and thus the marine life, in the lagoon and around these islands. The lagoon, which has a comparatively lower rate of flushing compared to more open sites, is particularly vulnerable to such pollution. Management of the proposed Park, therefore, should also seek to regulate the impact of human activities on the terrestrial communities, including sporadic wood-cutting and the expansion of land-clearing activities, as clearly any disturbed patch of forest will only recover its original structure over very many years.

It was of much interest during the survey that many standing dead trees were seen in the coastal mixed forest (Fig. 16). These included *Canarium asperum*, *Garuga floribunda* and *Shorea guiso*. In some patches, notably on the western arm of Bodgaya island, as many as 50% of the biggest emergents were dead this way. Discussions with Mr Jakaria bin Haji

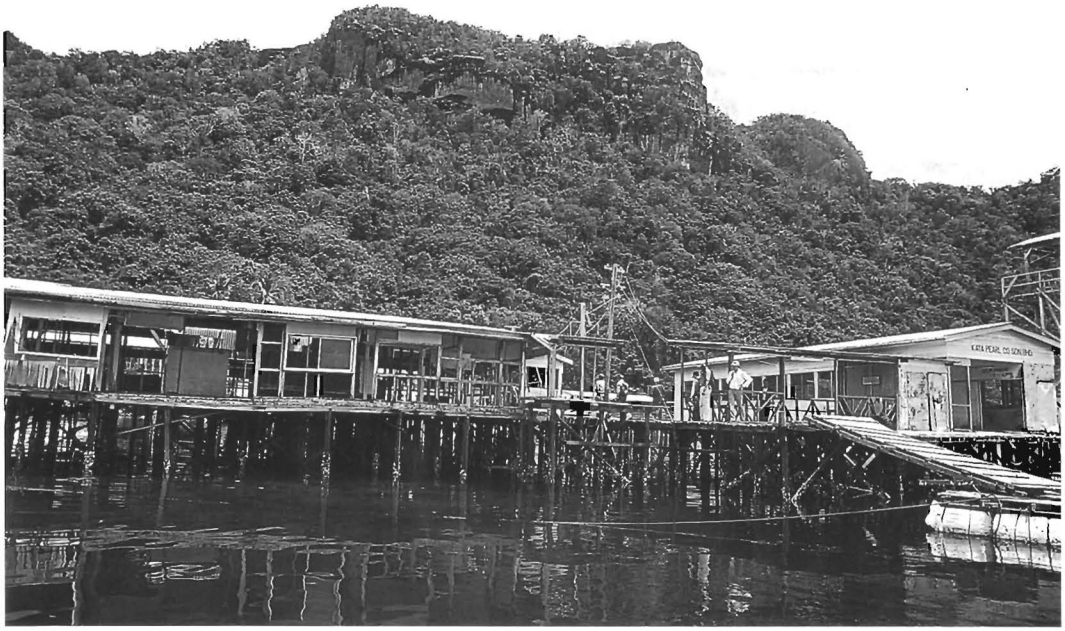

**Fig. 15.** The former Kaya Pearl Company's structures at Boheydulong Island, now in disuse; note regenerating coastal mixed forest just behind and a rock outcrop bearing scrub vegetation. (Photo: K.M. Wong)

**Fig. 16.** Dead *Canarium* tree crowns in the coastal mixed forest, south side of Bodgaya Island. (Photo: K.M. Wong)

Mohd. Jakob (Park Ranger, Sabah Parks), who has been based on Boheydulong island for the past four years, revealed that this extent of tree mortality came about only after the severe drought episode earlier in 1998. Such drought-induced tree mortality did not seem restricted to the largest individuals, as dead, standing saplings of *Hopea beccariana* were also encountered in several sites on Bodgaya island. Although overall, these mortalities appeared restricted to the commonest species and therefore did not seem to pose any special concern over the survival of tree populations, they were of interest, especially when it is considered that the volcanic soils are highly porous and the steep terrain probably also contributes to rapid run-off of water.

## CONCLUSIONS

The Semporna islands are no ordinary islands. They are the only wholly volcanic islands in Sabah with such an awesome, abruptly defined relief. By virtue of their origin and position at the south-western extreme of the Sulu volcanic arc, they are islands of a special geology that hold also some of the most interesting vegetation types and plant communities not encountered in other regions in Sabah or Borneo.

Phytogeographically, the Semporna islands are a natural conservatory of a good subset of the special Sulu flora (which is not found elsewhere in Sabah or the main island of Borneo), including good populations of such species as *Dracaena multiflora*, *Cycas rumphii*, *Euphorbia lacei* and *Garuga floribunda*. The uniqueness of the flora is enhanced by the presence of narrowly distributed endemics such as *Antirhea edanoi* and *Paraboea leopoldii*, as well as elements of the seasonal Asiatic flora (e.g., *Selaginella tamariscina*, *Stemona tuberosa*, *Rhyssopteris timoriensis*) that in Borneo perch only on these islands.

Along the backbone of the Sulu arc, only one notable cluster—the Semporna islands—is properly within Borneo and within Sabah's reach to ensure that much of its natural state will be adequately conserved. The vegetation of the small island Tetagan has been completely disturbed (although it now has regenerating forest of potential interest to coastal landscape managers) and the fringes of Bodgaya and Boheydulong have also been disturbed in places. However, a good proportion of the islands of Bodgaya and Boheydulong are still spectacular monuments of nature, with a rich and unusual assemblage of plant life. Taken in a wider context, the protection of the area of these islands as a Park accessible to carefully managed tourism will allow these features to be enjoyed with their attendant economic benefits, as well as the conservation of some truly unique aspects of Bornean flora, vegetation and marine life. In short, the unusual origin, geology, biogeographical position, landscapes and special natural plant communities of these islands together make up a profile that is as fascinating and worthy of conservation as the incredible marine life in their waters.

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